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Study designed to find valid predictor of success in graduate school for students in the Department of Applied and Mechanical Statistics returning to academic study after a lapse of several years. Three predictors of success were used: Undergraduate grade averages, the Miller Analogies Test, and the Doppelt Mathematical Reasoning Test. Three criteria of success were employed: Graduate grades, an academic competence rating, and a job-effectiveness rating. As a predictor of success for this particular group of students, the Miller test was ineffectual; the Doppelt test was the best single predictor as measured by any of the three criteria. The combination of all predictors added very little to the total correlation. None of the correlations was high enough to give strong confidence in any of the predictors. It was felt, however, that the Doppelt test could serve as a useful screening device.

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PREDICTION OF SUCCESS IN GRADUATE SCHOOL AT RUTGERS UNIVERSITY*

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THE PRESENT STUDY is part of a broad and continuing program of research on graduate student selection at Rutgers University. Although this paper concerns the Department of Applied and Mathematical Statistics, several other departments are also cooperating, namely the departments of English and Chemistry and the schools of Engineering and Agriculture. These results will be presented in forthcoming articles upon their completion.

The Department of Applied and Mechanical Statistics offers courses leading to the Master of Science degree for part-time evening students employed in local industry. Most of these students have returned to academic study after a lapse of several years. For this reason, it was felt undergraduate grades did not have the predictive significance they would have for recent graduates and another predictor was desired, preferably in the form of a convenient test. A total of 150 students enrolled in courses given by this department were tested and complete data for this study were finally obtained for 56 of these students. This constituted the experimental group, all of whom had been accepted for graduate study.

Three predictors of success were used, namely, undergraduate grade averages and two tests of The Psychological Corporation, restricted to use in graduate student selection, the Miller Analogies Test (1) and the newer Doppelt Mathematical Reasoning Test (2).² Three criteria of success were employed. They consisted of graduate grades, an academic competence rating, and a job-effectiveness rating. Further description of the predictors and criteria is given in the later sections of the article. In summary, three types of data were gathered: 1) Doppelt and Miller tests administered during the regular classroom period, 2) undergraduate and graduate grade averages and 3) rankings by instructors of academic competence and job effectiveness.

Predictors

The Miller and Doppelt tests consist of 100 and of 50 multiple-choice items respectively and employ a fifty-minute time limit. Both tests deal with the student's ability to discern relationships in items presented in the form of analogies. The Miller test deals with a wide variety of subject-matters and depends largely on the student's supply of factual information. The Doppelt test, not yet as widely employed, is designed to test the student's understanding of elementary mathematical concepts. Ability to utilize these commonly known concepts tests the student's mathematical reasoning ability. Thus it was felt that this instrument might prove to be an effective predictor for students of statistics.

The cumulative average for all undergraduate courses for each individual was available for use in this study. This score is based on the average of course grades weighted by number of credit-hours where the course grade is expressed by the number 1 for a grade of "A", 2 for "B", 3 for "C", 4 for "D" and 5 for a grade of "F". In the study the correlations between pairs of these predictors were computed. Correlation between Miller and Doppelt was .40 while that between undergraduate grades and either of the tests was near zero. In explanation of the rather startling lack of correlation with the undergraduate averages, it was felt that the diversity of standards among different institutions was probably an important factor. In addition, it is probable that a number of bright students did not do well when they were undergraduates for lack of motivation.

Criteria for Success

Graduate averages were computed in the same manner as undergraduate averages.

No attempt was made to define "academic com-

*Footnotes will be found at the end of the article.

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TABLE I
DISTRIBUTION OF RANKINGS FOR EXPERIMENTAL GROUP

Number of Rankings	Number of Students Receiving Indicated Number of Rankings
	10
2	9
3	14
4	11
5	9
6	<u>3</u>
Total	56

TABLE II
CORRELATIONS BETWEEN PREDICTORS AND CRITERIA*

	Graduate Averages	Academic Rating	Job Rating
Miller	.26	.25	.25
Doppelt	.32	.44	.31
Undergraduate Average	.24	.18	.22
Miller and Doppelt	.35	.45	.32
Doppelt and Undergraduate Average	.41	.48	.38
Miller, Doppelt and Undergraduate Average	.43	.50	.41

* All correlations are product-moment.

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petence" or "job effectiveness" beyond the information suggested by their labels and instructions for ranking supplied by the instructions. Judgment of academic competence was based essentially on conventional standards of classroom performance whereas the principle basis for judging a student's effectiveness on the job was his ability to transfer principles and knowledge acquired in the classroom to problems faced in the industrial setting. Students were required, as part of their courses, to submit term papers indicating such application.

The instructions for ranking were as follows:

"The attached list of students includes the names of those currently enrolled in courses in Applied and Mathematical Statistics. Will you please help us by ranking your students as follows:

1. Underline the names of all students you have had in class. If you don't recall the student well enough to have confidence in your judgment, also place a question mark beside the name.

2. Rank the students by quartiles in each of the two categories A and B on the attached sheet by writing one-fourth of the names underlined in each box on the accompanying sheet. (It is suggested you first pick the students you wish to rank at the extremes.)

- A. Your estimate of the student's academic competence.

- B. Your estimate of the student's effectiveness as a quality control engineer or administrator."

Thus a quartile ranking by each of the eight instructors in the department was prepared for each of the two criterion measures. A score of 1 was assigned to students ranked in the upper quartile, 2 for the second quartile, 3 for the third quartile and 4 for the lowest quartile. The number of rankings per student varied, of course, and the average of the ranks to one decimal point was used. In the treatment of data, individuals with less than four ratings were differentiated from those with four or more ratings. However, in the analysis of these data the dichotomy was abandoned since no reliable difference between the two groups was found, and these data were therefore combined.

Reasonable precautions were taken regarding experimental controls. Each instructor working independently ranked his group without reference to scores on any of the remaining variables. Of course each rater had information about the grades

he gave the student and perhaps grades they received in other courses. Correlation between graduate grades and academic rating was .79; between graduate grades and job rating was .61.

Analysis of Data

Machine computation was available for computation and a multiple correlation of predictors with the criteria. The results are shown in Table II.

The Miller test is seen to be ineffectual as a predictor for this particular group of students. The Doppelt test was the best single predictor as measured by any of the three criteria and particularly as measured against the academic rating.

The combination of all predictors added very little to the total correlation. None of the correlations is high enough to give strong confidence in any of the predictors. It is suspected that one important reason for this is the previously mentioned gap in the academic career of most of the group. Their success appears to be governed more by motivation than by the factors tested. It was felt, however, that the Doppelt test could serve as a useful screening device. Examination of scatter-diagrams suggested that a score of 30 was a reasonable cut-off point.

FOOTNOTES

- *1. The writers wish to express their appreciation to Deans Marion A. Johnson and John L. Swink and Professor Ellis Ott, all of Rutgers, for helping to make this research possible; also to the Psychological Corporation for making available without charge the Doppelt Mathematical Reasoning Test.
2. While time schedules could not be arranged to include the widely used Graduate Record Examination, its eventual inclusion in this battery as well as batteries for the other groups is planned.

REFERENCES

1. Miller Analogies Test Manual, The Psychological Corporation, 1952. New York.
2. Doppelt Mathematical Reasoning Test Manual, Psychological Corporation, 1958, New York.